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(71) Applicant(s)
Chas A Blatchford & Sons Limited

(Incorporated in the United Kingdom)

Lister Road, Basingstoke, Hampshire, RG22 4AH, United Kingdom

(72) Inventor(s)
Alan L Aulie
John Jeffrey Shorter

(74) Agent and/or Address for Service
Withers & Rogers
4 Dyer's Buildings, Holborn, LONDON, EC1N 2JT, United Kingdom

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(54) **Telescopic shin prosthesis**

(57) A shin prosthesis comprises first and second shin members (U and L) telescopically interconnected for relative movement along an axis extending longitudinally along the shin. The first shin member (U) defines an upper end which is connectable to a connector for connecting the prosthesis to a leg stump. Resilient means (8, 11) engage between the first and second shin members (U and L) for biasing the shin members longitudinally away from one another, and for resiliently resisting relative rotation therebetween.

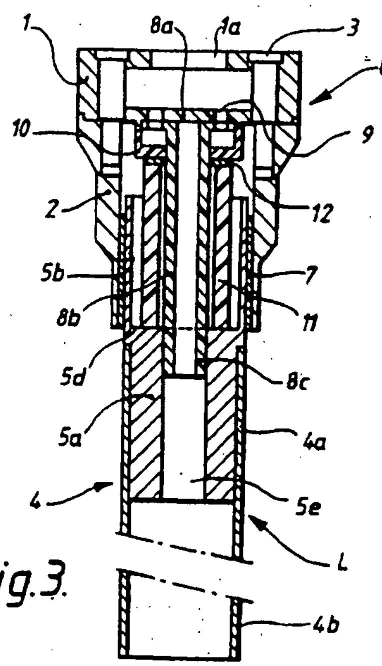

Fig.3.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

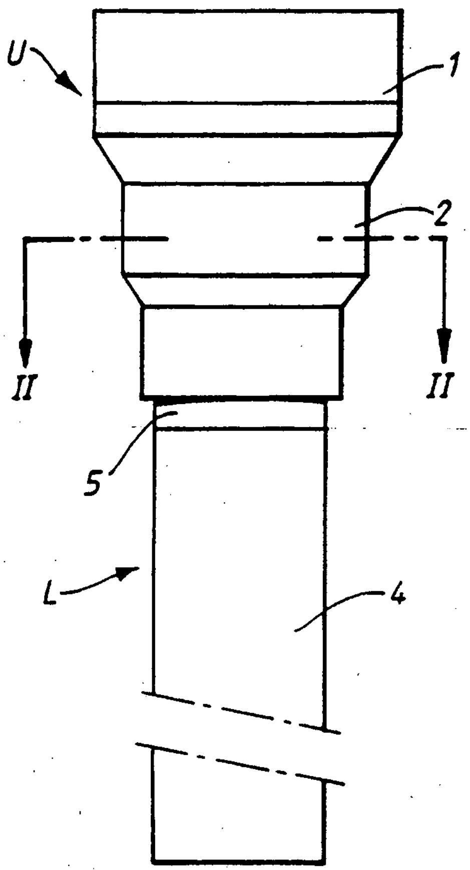


Fig.1.

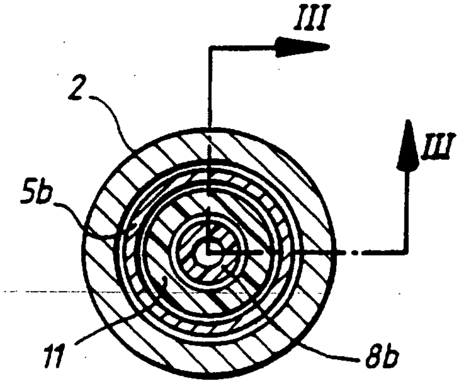


Fig.2.

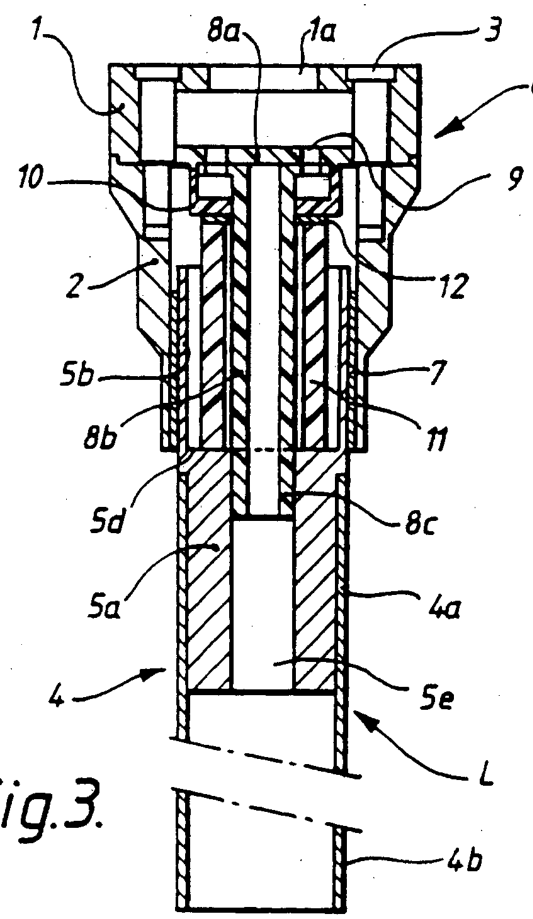


Fig.3.

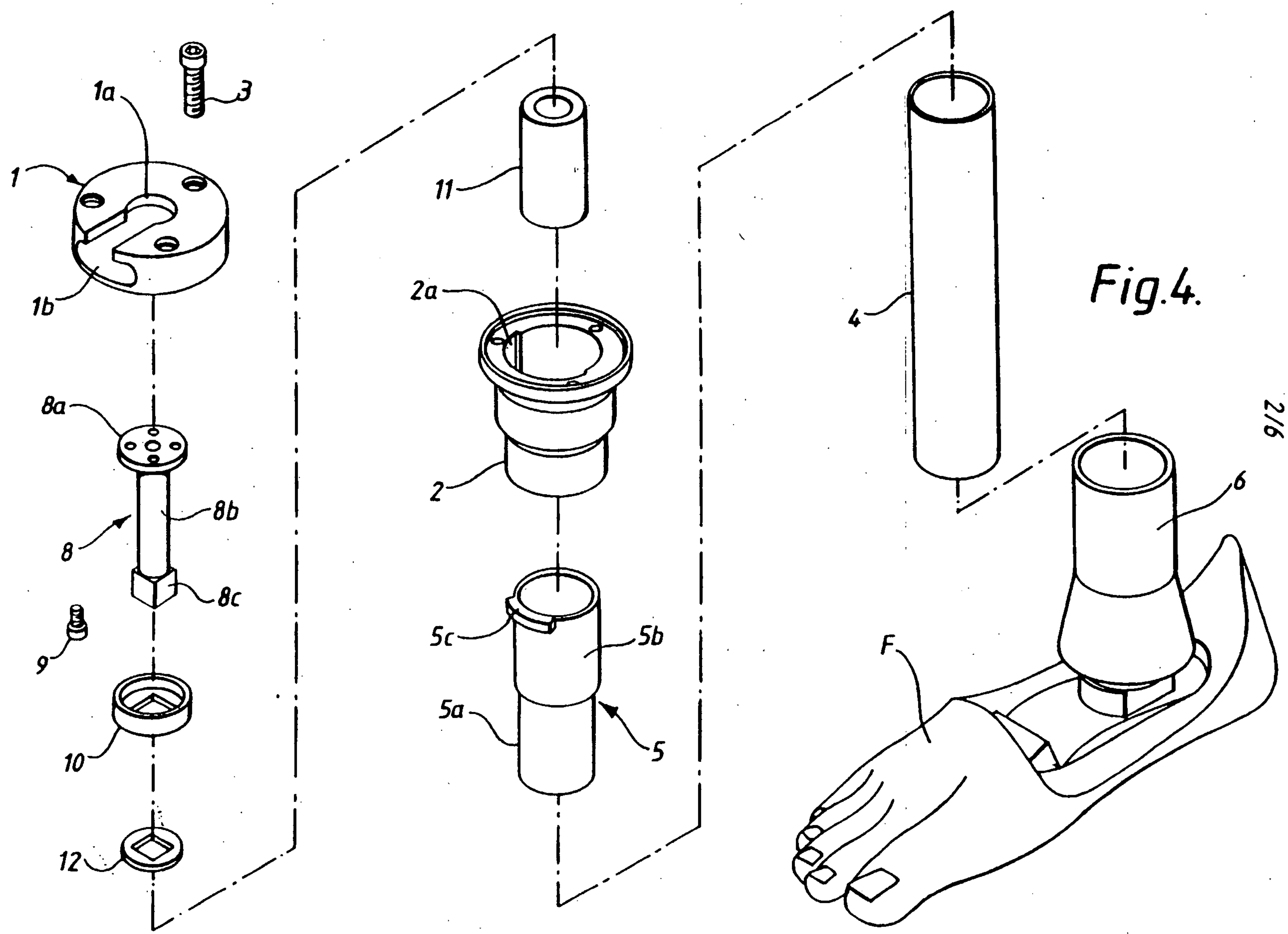


Fig.4.

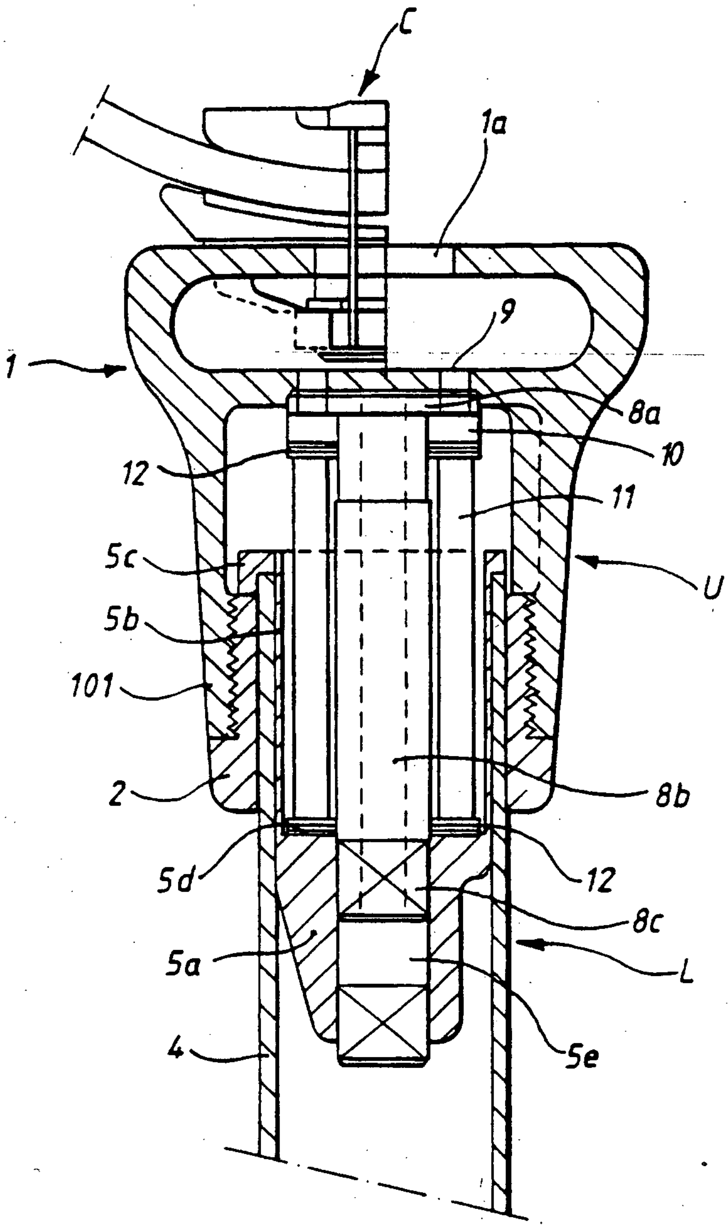


Fig.5.

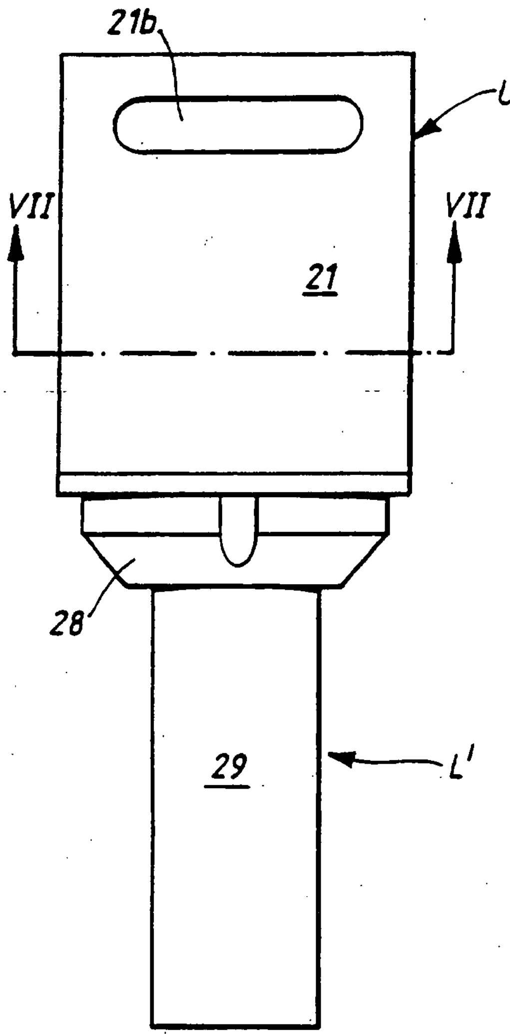


Fig.6.

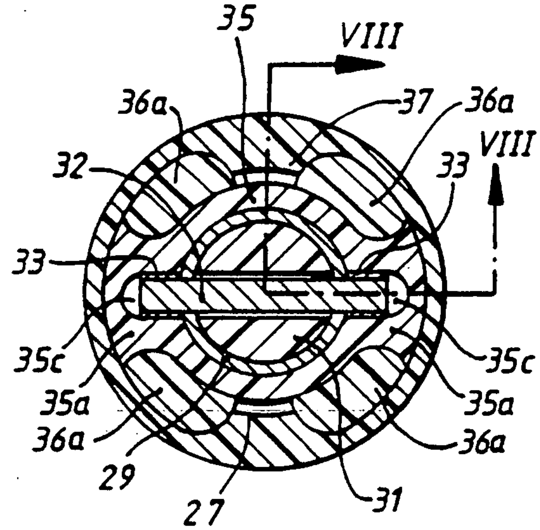


Fig.7.

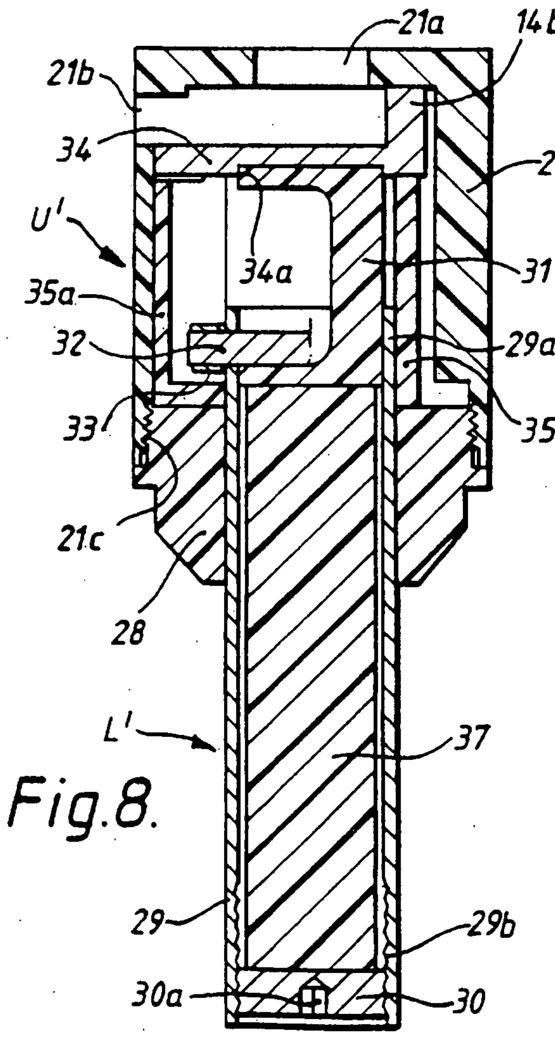
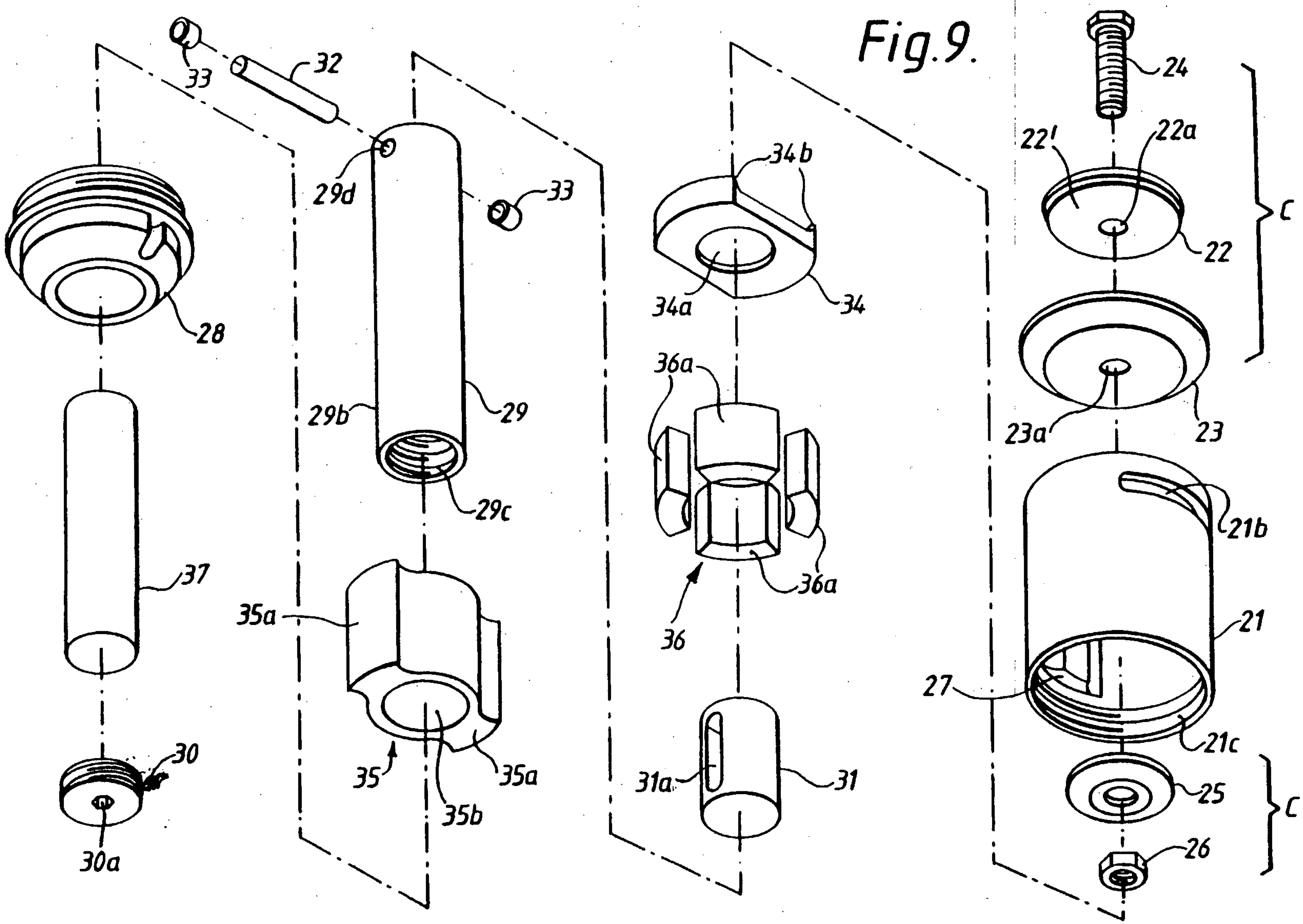


Fig.8.

Fig.9.



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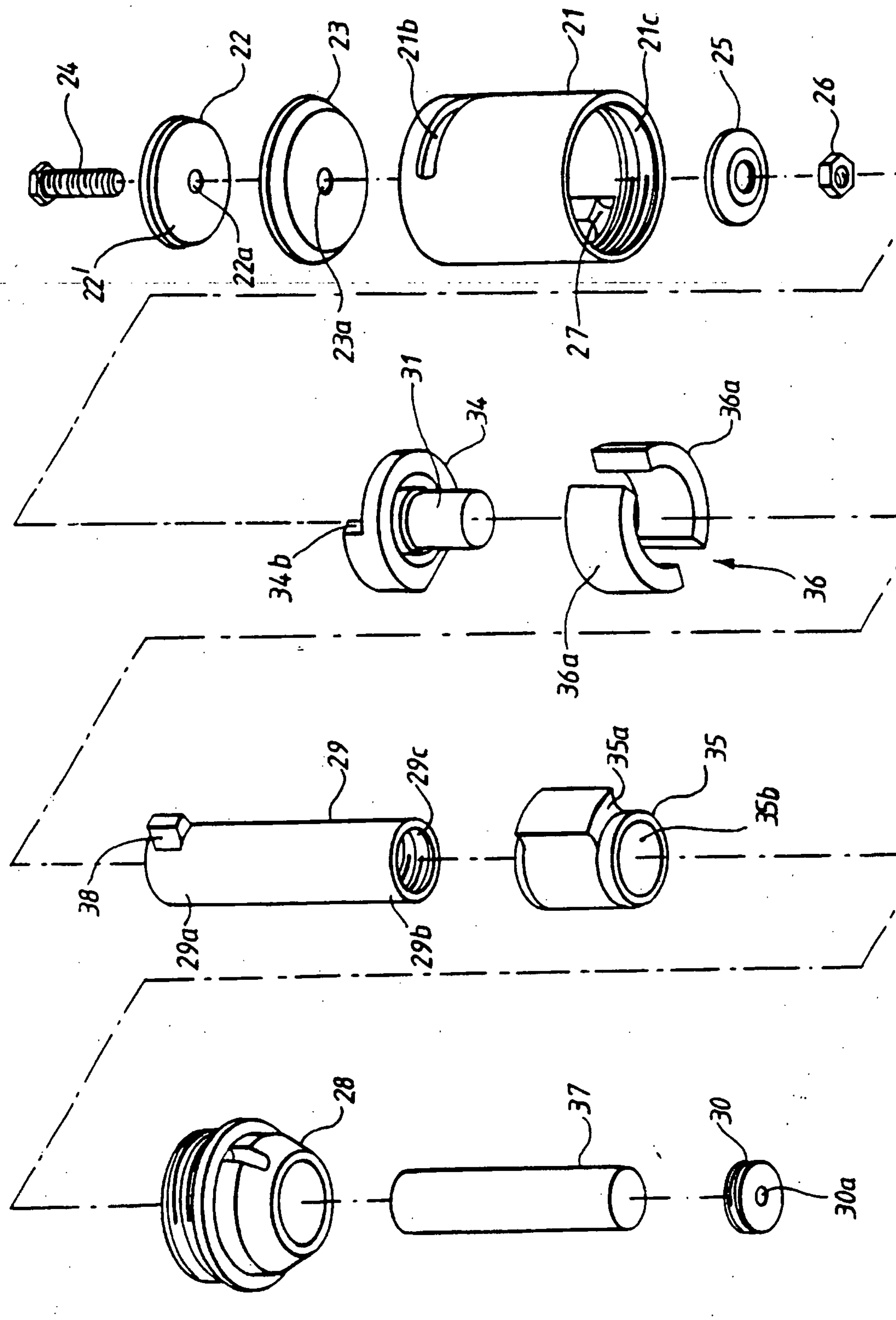
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Fig.10.

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SHIN PROSTHESIS

This invention relates to a shin prosthesis, and in particular to a below knee prosthesis with a resilient element in the shin.

It is usual for a leg amputee to wear a prosthesis in order to provide the wearer with improved mobility. Such a prosthesis should be comfortable to wear, and should simulate the natural movement of the replaced limb.

A known prosthetic shin includes first and second shin members which are telescopically interconnected to allow a change in length of the shin as weight and momentum are transferred through the shin during walking or running. A coil spring is engaged between the two shin members to provide a resilient interconnection therebetween. This known device requires the use of a separate damping piston to dampen the relative movement between the shin members, and to absorb impacts resulting from ground contact, thereby to relieve impact forces on the user's stump.

The aim of the invention is to provide an improved shin prosthetic device, and in particular to provide such a device which has improved stump protection properties.

The present invention provides a shin prosthesis comprising first and second shin members telescopically interconnected for relative movement along an axis extending longitudinally along the shin, the first shin member defining an upper end which is connectable to a connector for connecting the prosthesis to a leg stump, resilient means engaged between the first and second shin members for biasing the shin members longitudinally away from one another, and second resilient means engaged between the first and second shin

members for resiliently resisting relative rotation therebetween.

Advantageously, the resilient means is constituted by first and second resilient means, the first resilient means biasing the shin members longitudinally away from one another, and the second resilient means resisting relative rotation therebetween. The first resilient means may be constituted by an elongate elastomeric member.

In a preferred embodiment, the elastomeric member is generally tubular, and is housed between respective stop members provided on the first and second shin members. The elastomeric member may be made of neoprene.

Preferably, the second resilient means is a torque absorber tube, one end of which is mounted for rotation with the first shin member, the other end being mounted for rotation with the second shin member. Conveniently, said one end of the torque absorber tube is fixed to the first shin member, said other end being slidable relative to the second shin member. Advantageously, said other end of the torque absorber tube has a square cross-section which is slidably mounted within a complementary aperture formed in the second shin member; and said one end of the torque absorber tube is constituted by a plate which is fixed to the first shin member.

A thrust bearing may be positioned between the plate and the adjacent end of the tubular elastomeric member.

Advantageously, the torque absorber tube is made of a thermoplastics material such as nylon or Delrin.

Preferably, the torque absorber tube is positioned within, and extends axially in both directions beyond, the tubular elastomeric member.

In another preferred embodiment, the elastomeric member is generally cylindrical and is housed within a tubular member which constitutes the second shin member. Conveniently, the elastomeric member is positioned between an adjustable stop member detachably fixed to the tubular member at the free end thereof and abutment means housed within the first shin member. Preferably, the elastomeric member is positioned between the stop member and the abutment means with a predetermined degree of compression. This enables the prosthesis to be adjusted to suit different users - whose weights and body dimensions vary, thereby requiring the first resilient means to take up varying longitudinal forces.

In a preferred embodiment, the elastomeric material is a micro-cellular urethane material, whereby the first resilient means also constitutes damping means for damping relative longitudinal movement of the two shin members and for absorbing impact forces on the prosthesis, thereby relieving impact forces on the user's stump.

Preferably, the elastomeric member is a sliding fit within the tubular member. This prevents the elastomeric member being unduly deformed when compressed.

Advantageously, the first shin member is a generally cup-shaped housing, the second shin member being telescopically mounted therein by means of a cap screwed into the open end of the cup-shaped housing. Conveniently, the cap and the cup-shaped member are made of a thermoplastics material.

In a preferred embodiment, the second resilient means is constituted by torque absorber means, internal projection means being formed within the cup-shaped housing, and external projection means being associated with the first shin member, and wherein the torque absorber means is sandwiched between said two projection means.

Advantageously, the external projection means is formed on a bush which is slidably mounted on, but rotatably locked to, the second shin member. Preferably, the bush is formed with two diametrically opposed projections, the cup-shaped member is provided with a pair of diametrically internal projections, and the second resilient means is constituted by four arcuate torque absorber elements, each of which is sandwiched between a respective internal projection and a respective external projection. The torque absorber elements may be made of a volumetrically-compressible elastomeric material such as a micro-cellular urethane material, whereby the second resilient means also constitutes damping means for damping relative rotational movement of the two shin members. In this way shear forces on the stump are substantially reduced.

Advantageously, the abutment means is constituted by a base plate and an abutment member, the base plate supporting the one end of the abutment member and being supported by an abutment surface provided on the first shin member, the other end of the abutment member engaging with the elongate elastomeric member. Preferably, the abutment means is made of a thermoplastics material.

The second shin member may be rotatably locked to the bush by means of a pin passing through the second shin member and engaging with axially-extending recesses formed in the bush. In this way, the abutment member may be formed with a longitudinal slot, the pin passing through said slot so that the first shin member is movable longitudinally relative to the abutment member.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:-

Figure 1 is a side elevation of a first form of prosthetic shin constructed in accordance with the invention;

Figure 2 is a cross-section taken on the line II-II of Figure 1;

Figure 3 is a cross-section taken on the line III-III of Figure 2;

Figure 4 is in an exploded perspective view of the first form of prosthetic shin;

Figure 5 is a longitudinal cross-section, similar to Figure 3, of a modified version of the first form of prosthetic shin;

Figure 6 is a side elevation of a second form of prosthetic shin constructed in accordance with the invention;

Figure 7 is a cross-section taken on the line VII - VII of Figure 6;

Figure 8 is a cross-section taken on the line VIII - VIII of Figure 7;

Figure 9 is an exploded perspective view of the second form of prosthetic shin; and

Figure 10 is an exploded perspective view of a modified form of the prosthetic shin of Figures 6 to 9.

Referring to the drawings, Figure 1 shows a prosthetic shin having upper and lower shin members, indicated generally by the references U and L, telescopically interconnected in the manner described below. In use, the shin member U is fixed to a below knee socket (not shown) or to an extension of such a socket; and the shin member L is fixed to an artificial foot F (see Figure 4).

The shin member U is constituted by a cup-shaped base 1 (see Figures 3 and 4) formed with a circular aperture 1a in its end surface. The base 1 is made of aluminium. The base 1 is fixed to the below knee socket by means of clamping plates, a bolt, a washer and a nut (none of which are shown). An elongate slot 1b in the cylindrical wall of the base 1 provides access for a spanner which can be used to tighten the nut. The base 1 is fixed to a cap 2 by three screws 3. The cap 2 is made of aluminium or of a moulded thermoplastics material such as nylon or Delrin (RTM), and constitutes part of the upper shin member U.

The lower shin member L is constituted by a tube 4 made of carbon fibre and a stepped tubular member 5 made of aluminium. The upper end portion 4a of the tube 4 is bonded round the lower end portion 5a of the tubular member 5, and the lower end portion 4b of the tube is clamped to a shank 6 of the artificial foot F (see Figure 4). The upper end portion 5b of the tubular member 5 is a sliding fit within a bearing sleeve provided within the cylindrical bore of the cap 2. An outwardly-extending flange 5c is formed at the top of the upper end portion 5b of the tubular member 5, this flange being received within an arcuate cut-out 2a formed in the cap 2. The tubular member 5 is formed with an internal shoulder 5d in the region where the stepped portions 5a and 5b merge.

A torque absorber tube 8, which is made of a thermoplastics material such as nylon or Delrin, has an upper end plate 8a, an elongate central tubular section 8b and a square-section base member 8c. The end plate 8a is fixed to the cup-shaped base 1 by means of four screws 9, and the base member 8c is a sliding fit within a broached square hole 5e formed in the tubular member 5. The heads of the bolts 9 are housed in an end cap 10 made of nylon or Delrin (RTM), this cap being formed with a square aperture 10a in its base. A neoprene spring cylinder 11 is mounted between the shoulder 5d of the

tubular member 5 and the end cap 10, a thrust bearing 12 being positioned between the upper end of the neoprene spring and the end cap.

In order to assemble the prosthetic shin of Figures 1 to 4, the lower end portion 5a of the tubular member 5 is bonded to the tube 4. The cap 2 is then slid over the tube 4, with the flange 5c engaging within the recess 2a. The torque absorber tube 8 is then secured to the base 6 by the screws 9 which engage with tapped holes (not shown) formed in the underside of the base. The end cap 10 and the thrust bearing 12 are then positioned over the heads of the screws 9. The spring 11 is then slid onto the central section 8b of torque absorber tube 8. This top assembly is then slid into the tubular member 5. Finally, the base 1 is fixed to the cap 2 by the screws 3 to provide a predetermined pre-loading of the spring 11.

When the wearer of the prosthetic shin described above walks or runs, as the artificial foot F is placed on the ground, momentum and weight are transferred from the body of the wearer to the ground through the shin. The impact with the ground causes the lower shin member L to telescope into the upper shin member U, with the upper end portion 5b of the tubular member 5 sliding within the bearing sleeve 7 of the cap 2, thereby compressing the spring 11 between the shoulder 5d and the thrust bearing 12. The spring 11 is deformed by the compression process, becoming shorter and fatter, thereby permitting a relatively high pre-load of about 0.75 times body weight and a high spring rate (about 300 lbs/inch), while allowing the appropriate telescoping compression distance (approximately 1.25 inches) between the two shin members L and U. Moreover, the material of the spring 11 has a relatively long recovery time, so that the spring dampens the relative movement between the shin members L and U, and absorbs impacts resulting from the contact between the artificial foot F and the ground,

thereby relieving impact forces on the stump. The degree of pre-loading of the spring 11 can be varied, by changing spring elements or by adding spacers at its ends, to suit different users' requirements, for example to take account of different users' weights and body dimensions.

As the artificial foot F is lifted from the ground during walking or running, and the momentum and weight of the body of the wearer are no longer transferred through the shin to the ground, the spring 11 acts to force the lower shin member L outwardly with respect to the upper shin member U, so that the prosthetic shin is ready to take up the impact when the artificial foot is next placed on the ground.

When walking or running, rotational forces must also be taken up. This is no problem to a person with natural legs, but can cause problems for the wearers of artificial legs. This is because rotational forces are transferred through the artificial leg to the stump, and this can cause discomfort, chafing, and pain. The prosthetic shin described above is such as to take up these rotational forces, so that they are not transferred to the stump. Thus, as the lower shin member L rotates, this rotational force is absorbed by the torque absorber tube 8, the lower end 8c of which rotates with the tubular member 5 owing to the engagement between the base member 8c and the complementary hole 5e, whilst its upper end plate 8a is fixed to the base 1 of the upper shin member U. Resistance to relative rotation between the two shin members L and U is decreased by the thrust bearing 12. The degree of relative rotation is limited by the engagement of the flange 5c with the ends of the arcuate cut-out 2a. By varying the visco-elastic properties of the material of the torque absorber 8, the recovery time of the absorber can be varied to suit different users' requirements. Thus, some users like a relative long recovery time, so that the absorber dampens

the relative rotation between the two shin members U and L, thereby relieving shear forces on the stump.

As the artificial foot F is lifted from the ground during walking or running, or as the foot returns to a neutral position during the gait cycle, rotational forces are no longer transferred through the prosthetic shin. Consequently, the energy stored in the torque absorber 8 is released to rotate the lower shin member L relative to the upper shin member U, thereby returning these two members to their normal positions.

It will be apparent that the prosthetic shin described above could be modified in a number of ways. For example, the neoprene used for the spring 11 and the thermoplastics material used for the torque absorber 8 could be replaced by other elastomeric materials.

Figure 5 shows a modified form of the prosthetic shin of Figures 1 to 4. This modified form is very similar to that described above with reference to Figures 1 to 4, so like reference numerals will be used for like parts, and only the modified parts will be described in detail. Thus, the base 1 of the upper shin member U of the Figure 5 embodiment is formed with a hollow, cylindrical flange 101, and the cap 2 is a generally cylindrical sleeve. The cap 2 is externally threaded for locking the cap to the base 1 by engagement with a complementary internal screw thread formed within the flange 101. The tube 4 of the lower shin member L is bonded to the lower end portion 5a of the tubular member 5, and is clamped between the cap 2 and the upper end portion 5b of the tubular member 5. The spring 11 is pre-loaded between thrust bearings 12 at each end, the lower thrust bearing being supported by the internal flange 5d of the tubular member 5.

Figure 5 also shows connection means, indicated generally by the reference C, for fixing the upper shin member U to a below knee socket (not shown). This connection means is similar to that described below with reference to the embodiment of Figures 6 to 9.

Figures 6 to 9 show the second form of prosthetic shin having upper and lower shin members, indicated generally by the references U′ and L′, telescopically interconnected in the manner described below. In use, the shin member U′ is fixed to a below knee socket (not shown) or to an extension of such a socket; and the shin member L′ is fixed to an artificial foot (not shown).

The shin member U′ is constituted by a cup-shaped base 21 (see Figures 7 and 9) formed with a circular aperture 21a in its end surface. The base 21 is made of an acetal resin such as Delrin (RTM). The base 21 is fixed to the below knee socket by connection means C constituted by clamping plates 22 and 23, a bolt 24, a washer 25 and a nut 26 (see Figure 9). The clamping plate 22 fits inside the socket, and is formed with a convex clamping face 22′ which engages within a complementarily-shaped internal end surface of the socket. The clamping plate 23 has a concave end surface (not shown) which complements the external end surface of the socket. In use, the clamping plate 22 is positioned within the socket, and the clamping plate 23 is sandwiched between the socket and the external end face of the base 21. The bolt 24 is then threaded through apertures 22a and 23a in the clamping plates 22 and 23, and through the aperture 21a in the end surface of the base 21. The base 21 can then be fixed to the socket by tightening the nut 26 with the washer 25 positioned against the internal end surface of the base. An elongate slot 21b in the cylindrical wall of the base 21 provides access for a spanner which can be used to tighten the nut 26.

The base 21 is provided with a pair of integrally-moulded, longitudinally-extending, diametrically-opposed, internal projections 27. The open end of the base 21 is formed with a 10-pitch internal screw thread 21c which engages with a complementary external screw thread of a cap 28. The cap 28 is also made of an acetal resin such as Delrin (RTM), and constitutes part of the upper shin member U'.

The lower shin member L' is constituted by a stainless steel tube 29 which is, in use, a sliding fit within the cap 28, with one end portion 29a projecting beyond the cap into the base 21. The other end portion 29b of the tube 29 is formed with an internal screw thread 29c which threadingly engages with an adjustment screw 30. The screw 30 can be tightened or loosened using a hexagonal drive key (not shown) and a hexagonal drive slot 30a formed in the outer end surface of the screw. The end portion 29c of the tube 29 is formed with a diametrical through bore 29d.

A cylindrical abutment member 31 made of an acetal resin such as Delrin (RTM) is a sliding fit within the end portion 29a of the tube 29. The abutment member 31 is formed with a longitudinal through slot 31a. The abutment member 31 is connected to the tube 29 by means of a stainless steel pin 32 which passes through the slot 31a and the through bore 29d. Thus, relative longitudinal movement between the two members can occur, but relative rotational movement cannot. The pin 32 is held in place by a pair of end bushes 33 which are made of bronze. One end of the abutment member 31 is fitted within a shallow cylindrical recess 34a formed in a base plate 34. The base plate 34 is supported, in use, by the engagement of projecting end flanges 34b with the inside of the end surface of the base 21.

A rotator 35 formed with a pair of diametrically-opposed projections 35a and an axial through bore 35b is positioned as a sliding fit around the end portion 29a of the tube 29.

The rotator 35 is made of an acetal resin such as Delrin (RTM). At its upper end, the bore 35b is formed with a pair of diametrically-opposed recesses 35c (see Figure 7) which extend into the projections 35a, these recesses housing the end portions of the pin 32.

A torque absorber 36, which is constituted by four arcuate elements 36a, is positioned within the base 21, with each of the elements 36a positioned between a respective projection 27 of the cap 21 and a respective projection 35a of the rotator 35. The torque absorber elements 36a are made of a micro-cellular urethane.

A cylindrical spring 37 is positioned within the tube 29 in a pre-stressed condition between the screw 30 and the abutment member 31. The spring 37 is also made of a micro-cellular urethane material. As this material has a maximum length reduction of 25% at maximum compression, the spring 37 needs to be relatively long to ensure that there is a significantly long telescoping movement of the two shin members U' and L'. Moreover, the spring 37 is a relatively tight fit within the tube 29, so that the spring is not unduly deformed laterally when compressed. Thus, as the urethane spring material must be compressed volumetrically to attain the high spring rate necessary for this application - the material will not have a high spring rate until the cylindrical space surrounding it is completely filled, and compression of the device by axial loads reduces the volume contained within the cylindrical telescoping elements - the spring 37 must be an intimate fit within the tube 29 so that pre-loading takes up any free volume between the spring and the tube wall.

In order to assemble the prosthetic shin of Figures 6 to 9, the base 21 is first connected to the knee socket using the bolt 24, the clamping plates 22 and 23, the washer 25, and the nut 26. The abutment member 31 is then positioned

within the end portion 29a of the tube 29, and these two members are connected together using the pin 32 and the bushes 33. The rotator 35 is then slid over the end portion 29a of the tube 29, the ends of the pin 32 engaging within the recesses 35c. The base plate 34 is then positioned with its recess 34a housing the free end portion of the abutment member 31. The torque absorber elements 36a are then positioned around the rotator 35 so that, when the assembly described above is slid into the cup-shaped base 21, each torque absorber element is positioned between a respective internal projection 27 of the base and a respective external projection 35a of the rotator. The tube 29 is slid into the cap 28 until the flanges 34b of the base plate 34 rest against the internal surface of the end face of the base 21. The spring 37 is then positioned within the tube 29, and the screw 30 is screwed into the end portion 29b of the tube to provide a pre-determined pre-stress to the spring. The cap 28 is then slid over the tube 29 and screwed into the internal screw thread 21c of the base 21. The entire prosthetic shin is held together by the engagement of the cap 28 with the internal thread 21c of the base 21. Once the shin is assembled, the end portion 29b of the tube 29 can be fixed to an artificial foot.

Where the wearer of the prosthetic shin described above walks or runs, as the artificial foot is placed on the ground, momentum and weight are transferred from the body of the wearer to the ground through the shin. The impact with the ground causes the tube 29 of the lower shin member L' to telescope into the upper shin member U', with the tube 29 sliding within the cap 28, thereby compressing the spring 37 between the screw 30 and the abutment member 31. Because the material of the spring 37 is of micro-cellular construction, it is compressed volumetrically, thereby permitting a relatively high pre-load of about 0.75 times body weight and a high spring rate (about 300 lbs/inch), while allowing the appropriate telescoping compression

distance (approximately 1.25 inches) between the two shin members L' and U'. Moreover, the micro-cellular material of the spring 37 has a relatively long recovery time, so that the spring dampens the relative movement between the shin members and absorbs impacts resulting from the contact between the artificial foot and the ground, thereby relieving impact forces on the stump. The degree of pre-loading of the spring 37 can be varied, by adjusting the screw 30 to suit different users' requirements, for example to take account of different users' weights and body dimensions.

As the artificial foot is lifted from the ground during walking or running, and the momentum and weight of the body of the wearer are no longer transferred through the shin to the ground, the spring 37 acts to force the lower shin member L' outwardly with respect to the upper shin member U', so that the prosthetic shin is ready to take up the impact when the artificial foot is next placed on the ground.

The prosthetic shin of Figures 6 to 9 is also such as to take up rotational forces, so that they are not transferred to the stump. Thus, as the tube 29 of the lower shin member L' rotates, this rotational force is absorbed by the torque absorber elements 36a, these elements being resiliently compressed between the projections 35a of the rotator 35 and the projections 27 within the base 21, as the rotator 35 rotates with the tube 29 owing to the interaction of the ends of the pin 32 within the recesses 35c of the rotator. Here again, the micro-cellular material of the torque absorber elements 36a is effective in absorbing the torsional forces resulting from the rotation of the tube 29. Moreover, because of the micro-cellular construction of the torque absorber elements 36a, this material has a relatively long recovery time so that the absorber elements dampen the

relative rotation between the two shin members, thereby relieving shear forces on the stump.

As the artificial foot is lifted from the ground during walking or running, or as the foot returns to a neutral position during the gait cycle, rotational forces are no longer transferred through the prosthetic shin. Consequently, the energy stored in the compressed torque absorber elements 36a is released to rotate the lower shin member L' relative to the upper shin member U', thereby returning these two members to their normal positions.

It will be apparent that the prosthetic shin described above with reference to Figures 6 to 9 could be modified in a number of ways. For example, the stainless steel tube 29 could be replaced by an aluminium tube, and the micro-cellular urethane material used for the spring 37 and the torque absorber elements 36a could be replaced by other elastomeric materials having a long recovery time. It would also be possible to pre-load the torque absorber elements 36a prior to their insertion between the projections 35a and 27. This pre-loading would give the prosthetic shin a rotation-resisting capability which simulates that of a natural leg. Moreover, the degree of pre-loading could be varied to suit different users' requirements, for example to take account of different users' weight and body dimensions.

The prosthetic shins described above have a number of important advantages when compared with prior art devices. In particular, each provides resistance to longitudinal impact forces and rotational forces, and so provides protection against both impact and shear forces on the stump. This reduction in the effect of shear forces is particularly important for amputees with stump tissue problems (for example diabetics). The reduction of shear force problems at the stump is also advantageous to amputees

who indulge in sporting activities which give rise to higher rotational forces than normal walking or running.

Other advantages are that the components absorbing axial and torsional loads are isolated from one another, thereby facilitating the adjustment of their characteristics separately. Also, each entire shin assembly is made of relatively cheap components (many of which can be moulded with one screw-out core and one side-pull). Moreover, apart from the socket mounting parts, each of the prosthetic shins described above has no internal fasteners, and is easy to assemble.

The use of the micro-cellular material for the spring 37 in the embodiment of Figures 6 to 9 is advantageous in that it is a lightweight material. It is also silent in use, and is unaffected by water. Indeed, the entire prosthetic shin is made of materials which are not materially affected by the action of water, most of the components being of plastics material, apart from those made of stainless steel or bronze. Similar advantages accrue from using neoprene for the spring 11 in the embodiment of Figures 1 to 4.

Another advantage of the prosthetic shin of Figures 6 to 9 is that the use of the spring 37, which is made of a slow recovery material, enables the shin to be used with an artificial foot having a hard heel. This is advantageous in that a hard heel feels more natural than the soft heel which is normally used with well known artificial shins.

Figure 10 shows a modified form of the prosthetic shin of Figures 6 to 9. This modified form of shin is very similar to that described above with reference to Figures 6 to 9, and so like reference numerals will be used for like parts, and only the modified parts will be described in detail. Thus, the torque absorber 36 is constituted by two arcuate elements 36a, and these elements engage between a single

projection 27 formed within the base 21 and a single external projection 35a formed on the rotator 35. The only other difference between this embodiment and that of Figures 6 to 9 is that rotational forces are transferred from the tube 29 to the rotator 35 by means of an external key 38 formed on the end portion 29a of the tube 29 and a corresponding slot (not shown) formed within the rotator 35. The key 38 and the corresponding slot take the place of the rod 32 and the recesses 35c of the embodiment of Figures 6 to 9. As there is no pin 32, the tube 29 can slide relative to the slider 31, so that the latter does not need providing with a longitudinal slot.

Although the three forms of prosthetic shin described above are of particular use as below-knee devices, it will be apparent that they could also be used, together with suitable connection, for above-knee amputees.

CLAIMS

1. A shin prosthesis comprising first and second shin members telescopically interconnected for relative movement along an axis extending longitudinally along the shin, the first shin member defining an upper end which is connectable to a connector for connecting the prosthesis to a leg stump, and resilient means engaged between the first and second shin members for biasing the shin members longitudinally away from one another, and for resiliently resisting relative rotation therebetween.

2. A prosthesis as claimed in claim 1, wherein the resilient means is constituted by first and second resilient means, the first resilient means biasing the shin members longitudinally away from one another, and the second resilient means resisting relative rotation therebetween.

3. A prosthesis as claimed in claim 2, wherein the first resilient means is constituted by an elongate elastomeric member.

4. A prosthesis as claimed in claim 3, wherein the elastomeric member is generally tubular, and is housed between respective stop members provided on the first and second shin members.

5. A prosthesis as claimed in claim 4, wherein the elastomeric member is made of micro cellular urethane material.

6. A prosthesis as claimed in claim 4 or claim 5, wherein the second resilient means is a torque absorber tube, one end of which is mounted for rotation with the first shin member, the other end being mounted for rotation with the second shin member.

7. A prosthesis as claimed in claim 6, wherein said one end of the torque absorber tube is fixed to the first shin member, said other end being slidable relative to the second shin member.

8. A prosthesis as claimed in claim 7, wherein said other end of the torque absorber tube has a square cross-section which is slidably mounted within a complementary aperture formed in the second shin member.

9. A prosthesis as claimed in claim 7 or claim 8, wherein said one end of the torque absorber tube is constituted by a plate which is fixed to the first shin member.

10. A prosthesis as claimed in claim 9, further comprising a thrust bearing positioned between the plate and the adjacent end of the tubular elastomeric member.

11. A prosthesis as claimed in any one of claims 6 to 10, wherein the torque absorber tube is made of a thermoplastics material such as nylon or Delrin.

12. A prosthesis as claimed in any one of claims 6 to 11, wherein the torque absorber tube is positioned within, and extends axially in both directions beyond, the tubular elastomeric member.

13. A prosthesis as claimed in claim 3, wherein the elastomeric member is generally cylindrical and is housed within a tubular member which constitutes the second shin member.

14. A prosthesis as claimed in claim 13, wherein the elastomeric member is positioned between an adjustable stop member detachably fixed to the tubular member at the free end thereof and abutment means housed within the first shin member.

15. A prosthesis as claimed in claim 14, wherein the elastomeric member is positioned between the stop member and the abutment means with a predetermined degree of compression.

16. A prosthesis as claimed in any one of claims 13 to 15, wherein the elastomeric material is a micro-cellular urethane material, whereby the first resilient means also constitutes damping means for damping relative longitudinal movement of the two shin members and for absorbing impact forces on the prosthesis.

17. A prosthesis as claimed in claim 16, wherein the elastomeric member is a sliding fit within the tubular member.

18. A prosthesis as claimed in any one of claims 13 to 17, wherein the first shin member is a generally cup-shaped housing, the second shin member being telescopically mounted therein by means of a cap screwed into the open end of the cup-shaped housing.

19. A prosthesis as claimed in claim 18, wherein the cap and the cup-shaped member are made of a thermoplastics material.

20. A prosthesis as claimed in claim 18, or claim 19, wherein the second resilient means is constituted by torque absorber means, internal projection means being formed within the cup-shaped housing, and external projection means being associated with the first shin member, and wherein the torque absorber means is sandwiched between said two projection means.

21. A prosthesis as claimed in claim 20, wherein the external projection means is formed on a bush which is

slidably mounted on, but rotatably locked to, the second shin member.

22. A prosthesis as claimed in claim 21, wherein the bush is formed with two diametrically opposed projections, the cup-shaped member is provided with a pair of diametrically opposed internal projections, and the second resilient means is constituted by four arcuate torque absorber elements, each of which is sandwiched between a respective internal projection and a respective external projection.

23. A prosthesis as claimed in claim 22, wherein the torque absorber elements are made of a volumetrically-compressible elastomeric material.

24. A prosthesis as claimed in claim 23, wherein the elastomeric material is a micro-cellular urethane material, whereby the second resilient means also constitutes damping means for damping relative rotational movement of the two shin members.

25. A prosthesis as claimed in claim 14, or in any one of claims 15 to 24 when appendant to claim 14, wherein the abutment means is constituted by a base plate and an abutment member, the base plate supporting one end of the abutment member and being supported by an abutment surface provided on the first shin member, the other end of the abutment member engaging with the elongate elastomeric member.

26. A prosthesis as claimed in claim 25, wherein the abutment means is made of a thermoplastics material.

27. A prosthesis as claimed in claim 21, or in any one of claims 22 to 26 when appendant to claim 21, wherein the second shin member is rotatably locked to the bush by means

of a pin passing through the second shin member and engaging with axially-extending recesses formed in the bush.

28. A prosthesis as claimed in claim 27 when appendant to either of claims 25 and 26, wherein the abutment member is formed with a longitudinal slot, the pin passing through said slot so that the first shin member is movable longitudinally relative to the abutment member.

29. A leg prosthesis substantially as hereinbefore described with reference to, and as illustrated by, Figures 1 to 4, Figures 5 to 8, or Figures 5 to 8 as modified by Figure 9 of the drawings.

30. An artificial leg including a shin prosthesis as claimed in any one of claims 1 to 29.

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A5R (RFA)

Int Cl (Ed.6): A61F 2/60, 2/62

Other: ONLINE: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	(No relevant document found)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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